

ABSTRACTS OF PAPERS

Albert L. Tester Memorial Symposium

22-23 April 1976

A symposium, intended to be an annual event, was held in honor of Albert L. Tester, who, at the time of his death, was Senior Professor of Zoology at the University of Hawaii and an active participant in the affairs of the Department of Zoology in teaching formal courses, directing graduate student research, and serving on committees of the Department. The faculty and students of the Department of Zoology proposed an annual symposium of student research papers as a means of honoring, in a continuing and active way, Tester's lively encouragement of student research in a broad range of fields within marine biology. Papers reporting original research on any aspect of marine biology were solicited from students of the University of Hawaii. Income from contributions to the Albert L. Tester Memorial Fund of the University of Hawaii Foundation was used to provide two prizes, one for the best paper on fish or fisheries biology, Tester's own field of special interest, and one for the best paper in any other area. Papers were judged by National Science Foundation Distinguished Visiting Scholar Arthur M. Myrberg, Professor, Rosensteil School of Marine and Atmospheric Science, University of Miami, and by Drs. Julie Brock, James Shaklee, and John Stimson from the Department of Zoology, University of Hawaii. Papers were judged on quality, originality, importance of the research reported, and on the quality of the public presentation. Presentations honored with prizes were those of Paul Atkins with Dennis Gorlick, in fish biology, and of Tina Weatherby.

The Social Use of Space in the Hawaiian Ghost Crab, *Ocypode ceratophthalmus*

FREDERICK J. LIGHTER

I studied the spatial pattern and related social behavior of the Hawaiian ghost crab, *Ocypode ceratophthalmus*, using nearest-neighbor and "mean crowding" techniques. Analyses were made of 13 different natural populations, representing a total of 901 individuals. Density measurements for these populations range from 0.48 to 1.01 crabs/m²; "mean crowding" estimates range from 0.58 to 1.78 other individuals/quadrat/individual. In 10 of the samples,

the spatial pattern of the population was random. Of the remaining three populations, two showed a pattern of aggregation and one showed a pattern of uniformity.

Both sex and age differences were present in burrowing behavior and burrow structure. Juveniles of both sexes constructed two basic patterns of burrow structure: mature females and mature nonreproductively active males constructed a similar structure and reproductively active males constructed another. Behavioral differences in burrow defense and social interactions were also observed. All crabs defended their burrows by using one or two defensive behaviors; a burrow inhabitant either

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assumed a threat posture toward the intruder and/or chased the intruder. However, reproductively active males utilized two additional defensive behaviors. Physical interactions with intruders took the form either of pushing with folded chelae or of actual combat.

Field measurements have demonstrated that reproductively active male *O. ceratophthalmus* show a uniform pattern of spacing among themselves when total population density is below approximately 0.6 crabs/m². Behavioral evidence

indicates that one male will prevent another from constructing a burrow within a radius of 71 cm from his own burrow. When total population density rose above 0.6 crabs/m², the male pattern of uniformity was lost, and the pattern became random. Behavioral evidence also indicated that, at population densities above this level, territorial defense of a burrow is lost, and agonistic behavior occurs in contexts which are not related to habitation and defense of a burrow.

Light Adaptation Strategies of Hermatypic Corals

RANDI REDALJE

Hermatypic corals growing at low light intensities generally show flattened growth forms, low calcification rates, and deep pigmentation. These characteristics can be attributed to the physiological adaptations of their symbiotic zooxanthellae. The responses of zooxanthellae to a range of light intensities can be compared to the light responses of "sun-" and "shade-" adapted phytoplankton, where a decrease in light intensity generally causes an increase in cell chlorophyll-*a* content. Two species of coral, *Cyphastrea ocellina*, a shallow reef species, and *Leptoseris incurvans*, a deeper reef species, were placed in four light treatments (10-, 20-, 40-, 60-percent surface illumination) to investigate changes in pigment concentration and in numbers of zooxanthellae with changes in light. For both species, chlorophyll-*a* concentra-

tion/cm² coral tissue increased with a decrease in light. *Cyphastrea* showed a decrease in chlorophyll-*a*/cm² at the lowest light level; *Leptoseris* did not show this decrease. There was no change in the numbers of zooxanthellae with light. Chlorophyll-*a*/algal cell increased with a decrease in light for both species except at the lowest light level, where *Cyphastrea* showed a decline. These preliminary results indicate that the zooxanthellae of *Cyphastrea* are adapted to higher light levels than are those of *Leptoseris* and are unable to increase further their cell chlorophyll content at light levels lower than 20-percent surface light. *Leptoseris* zooxanthellae would be expected to show a similar decrease in cell chlorophyll content but at a lower light level than was used in this experiment.

The Role of Relative Size in Competition for Shelter by *Macrobrachium rosenbergii* (Decapoda)

JOHN BRAD PEEBLES

Relative size has been reported to be an important behavioral factor influencing dispersal in a number of crustaceans. This factor was studied by pairing two adult animals in elliptical tanks (diameter 1 = 137 cm, diameter 2 = 75 cm, water depth = 34 cm). These tanks offered no avenues of emigration. A series of 15 male pairs was studied. Observations

were made on the day of simultaneous introduction, two, three, and six days after introduction. Behavioral interactions were recorded only on the day of simultaneous introduction. Position in space was recorded on all four observation periods. A total of 360 minutes of observation was made for the 15 male pairs. The results of a partial correlation of shelter use

on relative differences in body length, body weight, length of right chela, length of left chela, and carapace length, indicate that relative differences in chela length and body weight play

important roles in determining the outcome of competition for shelter in *Macrobrachium rosenbergii*.

Anatomy and Functional Morphology of Dermal Collagen Fibers in Sharks

PHILIP J. MOTTA

The dermis of sharks consists in part of a highly ordered array of collagen fibers. These fibers form layers of alternately oriented sheets that run in helical paths around the shark's body. The fiber paths are oriented from dorsocranial to ventrocaudal and from ventrocranial to dorsocaudal.

As many as 46 layers of these strong, only partly extensible collagen fibers are found in adult *Ginglymostoma cirratum*. In all sharks examined, these layers were closely and firmly bound together by cross-over collagen fibrils that joined alternate layers.

The angle that the fibers make to the longitudinal axis of the shark varies from 90° in the occipital region to almost 0° in the caudal fin,

the majority of the angles lying from 50° to 70°. Fibers lying within the latter range are believed to undergo minimum change in length during contraction and resultant thickening of the lateral muscles that accompanies swimming; therefore, the fibers impose minimum restriction on the swimming shark.

The fiber layers are believed to serve at least in part a mechanically protective function and as a firm and evenly distributed anchorage for the body musculature.

Single layers of the more superficial collagen fibers overlie the ceratotrichia of the caudal fin, lending support to the flexible ceratotrichia and probably giving the fins additional support and rigidity.

Fecundity as a Measure of Reproductive Investment in Marine Fishes

STEPHEN RALSTON

Fish fecundity data are most frequently fitted to a power function where fecundity = α size β . Given some information about total energy intake, we see that estimates of the exponent (β) can provide insights into the manner in which available energy is allocated to growth, reproductive, and maintenance processes.

Fecundity exponents and their 95-percent confidence intervals have been determined for a variety of Hawaiian fishes. Estimates vary

widely between species and may reflect differences in the adaptation of species to their environment.

Estimates of β allow us to infer that allocation of energy toward reproduction may increase geometrically with the size and weight of the individual. A simple model is presented that explores alternative ways in which these increases may arise in *Chaetodon miliaris*, a Hawaiian endemic butterflyfish.

Comparative Ultrastructure of Intestinal Epithelia from a Freshwater Prawn and a Desert Scorpion

WILLIAM J. COOKE

The intestinal epithelia of the freshwater prawn *Macrobrachium rosenbergii* and the desert scorpion *Hadrurus arizonensis* are compared on

the ultrastructural level. The midgut cells of the prawn are similar in their shape and organization to generalized transporting epithelia. They are

long columnar cells having many long microvilli projecting into the lumen, a central or basal nucleus, extensive basal smooth endoplasmic reticulum, and a somewhat convoluted basal membrane. They are joined apically by well-developed septate desmosomes and occluding zonules. Many, if not most, of the mitochondria are located in the apical end of the cell, below the brush border. Epithelial cells from the scorpion have short sparse microvilli projecting into the lumen, longer microvilli being restricted to clefts between cells and canaliculi extending into the cells. The nuclei are located at the extreme basal end of the cell, where an extensively infolded basal membrane provides considerable amplification of cell surface area. The majority of mitochondria are located basally in these infoldings, with others present around the canaliculi. The scorpion hindgut is a major site of water absorption in these desert animals, and,

in some states of dehydration, the intestine is filled with precipitated guanine crystals.

The gut epithelial cells of the scorpion thus bear features (extensive basal infolding, localization of mitochondria) usually associated with active ion/water resorption organs (crustacean gills and segmental organ tubules), which may maintain a standing gradient in the basal region, as well as canaliculi and sparse microvilli typical of secretory cells in a rigorous environment (stomach HCl secretory cells). The cells of the prawn gut display features (long microvilli, apical mitochondria, extensive endoplasmic reticulum and Golgi bodies) of cells that are involved with absorption and protein synthesis. These morphological results tend to confirm the observed water flux and amino acid uptake properties that have been ascribed these cells from *in vitro* experiments.

Effects of the Cleaning Behavior of *Labroides dimidiatus* on Fish Ectoparasites

PAUL D. ATKINS AND DENNIS L. GORLICK

The idea that cleaning symbiosis is important for the control of ectoparasitism in marine fishes is a controversial hypothesis largely lacking empirical support. We investigated this problem at Enewetak Atoll by collecting samples of the copepod ectoparasite *Dissonus* sp. found on the host fish *Pomacentrus vaiuli*. *Pomacentrus vaiuli* were collected from three types of small lagoon patch reefs: (1) reefs with *L. dimidiatus*, (2) reefs without *L. dimidiatus*, and (3) a reef from which all *L. dimidiatus* had been removed.

The number of ectoparasites infecting individual *P. vaiuli* was low on all reefs and there were no significant differences among the reefs in the mean number of ectoparasites per fish. However, there were clear differences in the size composition of the copepod populations. The

data indicate that *L. dimidiatus* preys predominantly on larger *Dissonus* sp. individuals, effectively reducing their abundance on *P. vaiuli*. There were also indications of an increased abundance of smaller individuals on reefs with cleaners, which may explain why no difference in total numbers of ectoparasites per host was observed. The net effect of the cleaning behavior of *L. dimidiatus* is to reduce the total biomass of ectoparasites infecting host fish.

Potential benefit to the host in this cleaning symbiosis and interpretation of these results in light of the work of previous authors is discussed.

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The Use of Beach Crab Erythrophores as a Rapid Assay for Neurosecretion

TINA M. WEATHERBY

Red chromatophores of the common tropical beach crab *Ocyropsis laevis* are unusual in their rapidity of response to erythrophore-concentrating hormone. They are capable of changing from a fully expanded, stellate condition (stage 5) to a completely punctate state (stage 1) in less than 2 min. This change is brought about by a neurohormone released by the sinus gland, a neurohemal organ located in the eyestalks of crustaceans that consists of a dense aggregation of nerve terminals. The erythrophore response forms the basis of a highly sensitive, semi-quantitative bioassay for studies of neurosecretory release from the sinus glands of a variety of crustacean species. The meropodite segment of a walking leg from small (2.0–2.5 cm carapace width) animals is isolated and perfused with a physiological saline. Erythrophores become stellate within 20 min. For assay, the perfusion is stopped and the sample introduced; minimum required volume is 0.1 ml. The stage of expansion of five individual erythrophores is

scored. The average change of stage at 2 min when plotted against the log of concentration of sinus gland extracts (one sinus gland/0.6 ml H₂O), is linear for dilutions of 1×10^{-2} to 1×10^{-4} . This assay method lends itself well to electrophysiological studies of isolated sinus glands. Applying to the sinus gland 100 stimuli in trains of 5 per sec every 10 sec releases enough hormone in 0.1 ml solution to allow ready assay. The meropodite chromatophores and their responses to the hormone are relatively insensitive to ionic alterations of the saline; this has proved invaluable in studies of low (to 0) calcium and high (up to $10 \times$) potassium solutions on hormone release by sinus glands. Thus, this bioassay method is one of the most convenient yet devised for studies of neurosecretory systems.

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Food Habits of Two Sympatric Batfishes (Ogcocephalidae) Offshore of Cape Canaveral, Florida

GARY WINANS

The stomach contents of two sympatric batfishes (Ogcocephalidae) were analyzed. *Ogcocephalus* sp. and *Halieutichthys aculeatus* are demersal carnivores with noncrushing dentition and an illicium or luring apparatus just above the mouth. Samples containing both species were obtained 35 km offshore of Cape Canaveral, Florida, from April to December 1974. The standard length of *Ogcocephalus* sp. ranged from 85 to 150 mm (mean, 124 mm), whereas specimens of *Halieutichthys aculeatus* ranged from 33 to 92 mm (mean, 70 mm). *Ogcocephalus* sp. consumed primarily gastropods and pelecypods and *H. aculeatus* consumed primarily polychaetes. Neither species exhibited a qualitative change in diet with an increase in size or with respect to sex. However, there was a significant positive

correlation between the standard length of *Ogcocephalus* sp. and the size of prey items. *Ogcocephalus* sp. consumed principally scallops during cool water months (December through June) and gastropods during the warm water months (July through November). The diet of *Halieutichthys aculeatus* did not vary noticeably during the study period. Behavioral differences were noted between individuals of the two species that were being held in aquaria. Whereas *H. aculeatus* was sedentary and would flip gravel onto its back with its pectoral fins, *Ogcocephalus* sp. was more active and would slowly roam the bottom of the aquarium. Thus, the dietary and behavioral differences reported here suggest that systematic differences may exist in the foraging methods of these two sympatric batfishes.

Studies on the Coral-Boring Polychaete *Spirobranchus giganteus* (Serpulidae) in Hawaii

JANET WHITE

The tubiculous polychaete *Spirobranchus giganteus* inhabits living coral throughout the tropics. In Hawaii this worm occurs in the coral *Porites lobata*. Opercular and setal characteristics indicate that the subspecies in Hawaiian waters is *S. giganteus corniculatus*, also recorded from the Red Sea, western Pacific, and eastern Australia.

In situ *S. giganteus* is easily recognized by a raised ridge of coral that extends posteriorly from the tube aperture. Sections cut through worm burrows in the coral show that, anteriorly, the tube lies just beneath the coral surface, while posteriorly the tube penetrates at an angle into the coral skeleton. The posterior end of the burrow is not tapered to a point, indicating that the worm may be laying down tube over the surface of the coral while at the same time extending the burrow into the coral, but this has not been proven.

The larvae of *S. giganteus*, which are typical trochophores, survived 23 days in filtered sea-

water on a diet of *Chlorella*. Eight-day-old larvae have well-developed eye spots and telotroch, and the digestive system is clearly delineated by the presence of ingested *Chlorella*. Fourteen-day-old larvae have developed three setigers that bear simple setae. Settlement and metamorphosis begin at approximately the 17th day. Prior to settlement the larvae crawl on the substrate, trailing a mucuslike material that appears to be produced posteriorly. At this stage the collar is clearly visible and the post-trochal region is elongated and orange-brown in color. Transparent tubes are produced by the metamorphosed individuals. None of the larvae survived past this stage. Various substrates, including coral fragments, mollusc shells, and coralline algae, were provided for settlement; however, in every case the larvae settled on the plastic culture dishes.

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Nesting Rhythmicity in the Damselfish *Plectroglyphidodon johnstonianus* (Perciformes, Pomacentridae) in Hawaii

CRAIG D. MACDONALD

The nesting frequency of a total of 70 nesting males of the damselfish *Plectroglyphidodon johnstonianus* was continuously recorded at 6-day intervals for 19 months in Kaneohe Bay, Oahu, Hawaii. Two peaks in the spawning frequency of nesting males occur annually from September through October and again from February through May. Time series analyses by periodogram indicated that three oscillatory components of approximately 120-, 180-, and 360-day periods

are responsible for the observed rhythmicity. A lunar component does not exist. It is anticipated that several differentially phased, inter-related environmental cues will be found to be responsible for the entrainment of this rhythm in adults. There is also some agreement between periods of peak production of damselfish larvae and the periodic maximum densities of micro-copepods upon which the larvae presumably prey.

Mechanism of Thermoregulatory Heat Production during Cold Acclimation in the Rat: Role of Active Na^+ Transport

DUANE L. GUERNSEY

I tested the hypothesis that active Na^+ transport is stimulated during cold acclimation to provide increased calorogenesis by measuring $\dot{Q}\text{O}_2$ - and Na^+ -independent respiration of skeletal muscle (pectoral muscle and diaphragm), liver, and kidney slices from cold exposed and control rats. The time course and pattern of $\dot{Q}\text{O}_2$ activation was different for the three tissues; when their responses were combined, the net response was consistent with the pattern of non-shivering thermogenesis. In all tissues studied, the increased energy utilization by the Na^+ pump was responsible for the major fraction of in-

creased $\dot{Q}\text{O}_2$ produced during cold acclimation: stimulation of active Na^+ transport accounted for 84 percent of the total increase in $\dot{Q}\text{O}_2$ in the diaphragm, 71 percent in the pectoral muscle, 83 percent in the liver, and 64 percent in the kidney. It is suggested that the calorogenic process of active Na^+ transport via the membrane Na^+ pump is an important source of thermoregulatory heat production during cold acclimation in the rat.

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